Monitoring CO_2 Geosequestration Using Distributed Thermal Measurements

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The geosequestration of large quantities of CO_2 will lead to changes in the temperature of the storage reservoir. Heat transfer in the reservoir during injection occurs primarily by two physical processes: (1) the advective movement of injected CO_2 and displacement of formation fluids (either gases, brines or some combination thereof), and (2) thermal conduction by natural diffusive processes. Because advection is the principal mechanism for heat transfer during CO_2 emplacement, and heat diffusion will dominate the subsequent trapping/storage phase, monitoring the evolution of the thermal profile within the reservoir can provide information on the lateral extent and thickness of the emplaced CO_2 and the effectiveness of stratigraphic trapping mechanisms. To successfully interpret measured temperature data, the thermal conductivity and heat capacity of the reservoir and reservoir seal need to be well constrained. The commercially available distributed temperature sensor (DTS), and the newly developed distributed thermal perturbation sensor (DTPS) provide a means for acquiring the necessary temperature data for monitoring the evolution of geosequestered CO_2. Numerical simulations are presented that demonstrate the use of DTS and DTPS measurements for assessing CO_2 storage reservoir performance. Thermal measurements are shown to be effective for monitoring CO_2 geosequestration, especially when complemented by other accepted monitoring technologies.